Developing and Fielding Information Dominance

Space and Naval Warfare Systems Command's
IT-21 Blocks 1 and 2

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ABSTRACT

This paper describes the process improvements that comprise the Space and Naval Warfare Systems Command's Horizontal Integration Initiative. It tells how these process improvements are leading to improved C4ISR capability, sustainability, and cost effectiveness as the System Command fields successive Blocks of its *horizontally integrated* product line: "IT-21."

The process improvements represent a holistic view of 'end to end' capabilities: commonality in hardware, software, and data structure; tight configuration management; built in ILS; and rigorous testing to horizontally integrate shipboard C4ISR designs.

The paper recounts how these improvements became the foundation for SPAWAR's IT-21 re-engineering initiative; and discusses development and fielding plans for the Fleet's first *fully integrated* C4ISR architecture: IT-21 - Block 1.

An organizational overview of the IT-21 Block 1 architecture, within its functional enclaves (GENSER, SCI, UNCLAS, Networks, Transport), lists key features of the 'end to end' design package. As Block 1 readies for delivery in 2003, development of its successor architecture, IT-21 Block 2, is already underway. The features of the IT-21 Block 2 design process - requirements analysis, technology insertion, interface planning, and cost/benefit analysis - provide insight into the dynamics which will shape Navy C4ISR in years to come.

INTRODUCTION

"In warfare, information superiority will significantly increase the speed of command, enabling forward deployed and early-entry forces to take the initiative away from numerically superior enemy forces and set the conditions for early, favorable termination of conflict."

- Quadrennial Defense Review Secretary's Report to Congress (1997)

I. FORWARD

Virtually concurrent with the Quadrennial Defense Review, the Navy declared intention to fulfill its precepts by leveraging industry's R&D investments in Information Technology (IT), and embrace Commercial Off the Shelf (COTS) solutions. In the five years since, it has sometimes surprised visitors to the Space and Naval Warfare Systems Command that the term "System of Systems" - a catchphrase in commercial IT circles - was so unwelcome at the Navy's IT directorate. RADM John Gauss, former COMSPAWAR (1998-2001) [1], had hated the term. It effectively endorsed defining

[1] RADM Kenneth D. Slaght assumed Command as COMSPAWAR on 25 May 2001.

systems that should be *whole* by their divisions, and was an anathema to his plans to integrate Navy IT.

RADM Gauss' war on "stovepipes" was a personal one, and he referred it to each of his subordinates. His strategy in this weighty mission was to implement an array of process improvements to *Horizontally Integrate* the entire SPAWAR C4ISR product line into 'end to end' capabilities. These 'end to end' capabilities would be tightly managed for commonality, integration, and cost efficiencies. The physical implementation of the capabilities would be *packaged* - configuration managed and delivered - in 'Block' designs, according to ship class, Battle Group assignment, and successive *Block* fielding windows.

In combination, the Horizontal Integration process, and the resulting Block architectures for hardware and software, are defined as the Information Technology 21st Century (IT-21) Initiative.

II. TOWARDS NETWORK CENTRIC WARFARE

In the several months following RADM Gauss' retirement, his hand remains evident in declaring the tenets of IT-21, and his advisements for technical approaches or performance standards continue to be referenced. But if, as COMSPAWAR, he had served as the program's chief guide and mentor, a full accounting of IT-21's lineage is appropriately traced back to Admiral Archie Clemins, who, in successive billets commanding Fleet operating forces, secured the original mandate to rethink Navy IT.

In the early nineties, Navy leaders chafed that Desert Storm Air Tasking Orders (ATO's) needed to be delivered to afloat units by helicopter; because at-sea communication pipes couldn't ingest the phonebook sized plans even as fast as they could be printed and flown from shore nodes. Un-repaired, such shortfalls could constrain the Navy in performing theater command and control…just when Joint Doctrine was pointing out the need for 'speed of command' in executing littoral missions.

Joint Doctrine was itself being changed by the twin dynamics of new-world-order missions and the explosive transformation of civil society by information networks. A Revolution in Military Affairs was ordered in the 1997 Quadrennial Defense Review and the futuristic Joint Doctrine statement, Joint Vision 2010. Collectively this revolution would innovatively apply new *(information)* technologies to fundamentally alter the character and conduct of military operations. If the virtues of reduced force levels were uncertain, the necessary role of information dominance to maintaining strategic superiority was not. Platform Centric Warfare, with its reliance on mass and attrition, would give way to Network Centric Warfare. Information that was better, and came faster, and was more broadly distributed, could tilt the fog of war on adversaries - to achieve early and less costly victories.

III. DEFINING IT-21

As ADM Clemins progressed through tours as Deputy and Chief of Staff to Commander in Chief, Atlantic Fleet; Commander Seventh Fleet; and Commander in Chief Pacific

Fleet, he became convinced that the complexity and diversity of Navy IT programs distracted resources and compromised their utility to Fleet sailors. He coined his remedy "Information Technology 21st Century" (IT-21), and expressed its principles in the self-help vernacular of the day:

The Seven Habits of a Highly Effective Information System

1. If the boss doesn't use it, don't buy it!
2. Tactical and non-tactical applications must be integrated.
3. We must stay common with industry
4. All applications must be driven to a single PC.
5. We must use COTS wherever feasible.
6. Sea to shore transitions must be seamless.
7. No stovepipes!

Self-descriptive and to the point, the Seven Habits were themed by commonality, seamlessness, and an observation that commercial sectors would drive the future course of technology. Arcane solutions were out. Like a contemporary commercial that asked, "What is the most powerful computer?" and answered, "The one that gets used", the Navy would adopt commercially standard operating systems and run applications that would look and feel like those sailors used at home.

Being seamless and network centric begged a measure of performance question: "At what level?" ADM Clemins set the criteria, first, at the Battle Group; and determined that the BG, with its aircraft carriers, cruisers, destroyers, and submarines, would be IT engineered as an integrated whole. This holistic approach gave rise to a concept of *'packaging'* - designs, installations, logistics support - that remains at the core of the IT-21 strategy. Setting precedent, the entire Battle Group would be engineered as a single design entity. Operating systems and software versions were steadfastly held common, and minimum standards were ordered for wideband satellite access and shipboard LAN capacities… *for every ship in the IT-21 Battle Group.* Moreover, these equipment packages, these IT-21 systems, would be delivered as a whole. Installations would be centrally planned, managed, and *tested* at the Battle Group level. The testing bar was pledged to move from the 'box' to the Battle Group, and success recorded only if the *Battle Group* shared data as an 'end to end' C4ISR system.

IV. MIN-IP AND IT-21 PLUS

Interior to the desire to leverage networks and follow industry was the intent to speed the web-enablement of Fleet operating forces. Worldwide networks of all stripes were exponentially producing new information, but it did little good if the data bottlenecked, waiting for an open voice circuit, or piled up in reams of text message traffic. The Navy Virtual Internet offered, instead, that afloat meteorologists or intelligence specialists could scan thousands of databases, pulling information specific to their needs at the click of a desktop mouse. The seamless transmission of information from shore based WANs to shipboard LANs, meant the infrastructure must be emplaced on both ends to facilitate transfer of voice, video, and text via the DOD Non-Classified and Secret Internet Protocol Router Networks (NIPRNET, SIPRNET).

To this end, in 1997, the first IT-21 Battle Group and Amphibious Ready Group, centered around USS Abraham Lincoln and USS Essex, were outfitted with equipment that came to be known as the Minimum IP, or "MIN-IP", sets. MIN-IP provided the down payment on the standardized desktop toolkit, a high performance ATM LAN with SIPRNET access, and off ship satellite transport, (minimally 64 KBS INMARSAT to escorts, as much as 1.55MBS to SHF equipped large decks). Specifically, MIN-IP directed:

- 200 MHZ Pentium CPU workstations
- 64 MB RAM
- 3 GB hard drives
- Windows NT 4.0; MS Exchange e-mail
- OC 3 (155 MBS) ATM backbone
- 100 MBS to desktop
- 64 KBS to 1.55 MBS Wideband satellite access[2]

Later, similar upgrades, adding an additional 64 KBS INMARSAT to escorts, and NIPRNET access, were provided to follow on BG's and ARGS's: Kitty Hawk/Belleau Wood and Enterprise/Nassau.

In themselves, none of these upgrades represented new technology or new procurement programs. VADM Natter, OPNAV N6[3], described the IT-21 packages as a "Fleet driven re-prioritization of C4ISR programs"[4]. Perhaps the IT-21 MIN-IP packages lacked the flash of glitzy industry demos, but their value to Navy Command and Control was quickly substantiated during Fleet operations in response to tensions in the Straits of Taiwan. SECNAV and CNO subsequently testified to Congress:

"Recent Navy experience responding to the Taiwan Straits crisis exemplifies the concept of speed of command and the fundamental organizational and doctrinal changes it portends. With the use of e-mail, video teleconferencing, and an intuitive graphics rich medium instead of traditional message text, the timeline from planning to execution was dramatically compressed. The result was an ability to collaboratively plan and execute in a dynamic environment. Higher sustained situational awareness resulted in fewer questions, clarity of mission and commander's intent, and no ambiguity."[5]

It must have been satisfying, too, when ADM Clemins reported:

"During (Fleet Exercise) Tandem Thrust, the Air Tasking Order (ATO) was regularly distributed to 18 remote sites on the network, *one as far away as Louisiana*, in two

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[2] In some ways, the MIN-IP set is telling for more than being a first step: four years later, the minimum capabilities specified seem *so minimal*, and list some technical approaches already scrapped, that the challenge of judiciously managing the pace of IT change is underscored.
[3] Director Space, Information Warfare, Command and Control; Office of Chief of Naval Operations.
[4] Hon. John Dalton, ADM Jay Johnson. Testimony to Research and Development and Procurement Subcommittees of the House Armed Services Committee on Defense Information Superiority and Information Assurance Entering the 21st Century; 23 February 1999.
[5] Response for the Record, Senate Armed Services Committee Navy Posture Hearing on Information Technology, 26 February 1997.

minutes. Sites not on the network required up to 10 hours by conventional data transmission or the physical transfer of the ATO by hard copy."[6]

V. HORIZONTAL INTEGRATION

MIN-IP and its successor design, "IT-21 Plus" were implemented aboard Carrier Battle Groups (CVBG's) and Amphibious Ready Groups (ARG's), as they cycled through pre-deployment shipyard availabilities, until RADM Slaght reported in late 2001: "From a seed that was planted only about three years ago, by 1 October about 88 percent of the fleet will be online and connected to the network-that is what network-centric enablement is all about."[7]

In the midst of fielding these synchronized capability upgrades, SPAWAR, as an entire Command, was forced to square off against the looming Y2K threat. Though with time's passage the Y2K bug is remembered as a 'non-event', that accounting underestimates the countless hours of planning and pre-crossover testing that assured the rollover had a forgettable outcome. Clear of the Y2K threat, RADM Gauss turned the 'battle staff' he had assembled from across the Systems Command (SYSCOM) to the work he really wanted to undertake: the "Horizontal Integration" of the entire 'end to end' Navy C4ISR product line.

Horizontal Integration is a collection of process improvements that sometimes gets confused with its resulting product: the successive IT-21 product lines. Horizontal Integration infuses the product line with features, but doesn't specify it as an architecture. Fundamentally, Horizontal Integration is intended to increase the capability, capacity, and accessibility of the Navy C4ISR architecture – while reducing its cost.

As the term itself implies, Horizontal Integration has much to do with commonality: common hardware, common operating systems, common networks, and common standards for software applications development. This commonality directly opposes stovepipes, and pre-plans C4SIR architectures to eliminate them. The commonality is, moreover, focused on end state capabilities, appraising the C4ISR architecture as a *utility* of sorts, created to provide the warfighter an integrated toolkit of functional capabilities. Assessing the functional characteristics of these capabilities, and pre-planning their incorporation into design, is at the heart of the HI process. So with his staff, collected to work across architectural domains to thwart Y2K, RADM Gauss set Horizontal Integration to work as a collective process. As Horizontal Integration emerged it established performance criteria that would necessarily define its resultant IT-21 architectures.

Horizontal Integration is Defined By:

- Pre-Planned, Data Level Integration
- Tightly Coupled H/W & S/W Baselines

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[6] Omori and Sommerville eds. , Strength Through Cooperation: Military Forces in the Asia-Pacific Region; National Defense University Press, 2000.
[7] "Interview with RADM Kenneth D. Slaght, Commander SPAWAR", CHIPS, Fall 2001

- Single Installation Event for C4ISR Products
- Ship-wide Configuration Management
- 'End to End' Testing Prior to Delivery
- Coordinated OPTEVFOR Block Testing
- Pre-packaged Security; Common Certifications
- Built-in, Single Delivery ILS

Pre-Planned, Data Level Integration refers first to the upfront systems engineering which resists looking at the C4ISR system as a series of interfaces, in favor of considering it – planning it – as a single integrated whole. This whole system, from communications antenna to workstation application is planned to provide access from common workstations to common databases, and capitalize on access to Fleet and DOD web enabled infrastructures. A key goal is seamless access to tailored databases without need to shift between applications, workstations, or networks.

Tightly Coupled H/W & S/W Baselines reflect resolve to foster system integration, between applications and between ships, through highly disciplined – *tightly coupled* – fielding plans for hardware and software. Releases of new hardware are tied to 'Block' releases of IT-21 versions, based on a two-year IT-21 Block fielding cycle. Software releases will be likewise constrained to a single update for critical upgrades, within the two-year hardware release cycle.

Single Installation Events for C4ISR Products capitalizes on SPAWAR's creation of an Installation Management Directorate (SPAWAR 04, The "Chief Installer") within the Systems Command. Thus, installation of every IT-21 hardware and software component will be centrally managed to assure commonality in installation processes and performance standards. Technical documentation, interface management, and performance testing at delivery, are centrally and uniformly managed against strict quality assurance standards.

Ship-wide Configuration Management provides a holistic approach to managing change within the two-year Block delivery cycle. Changes are tightly packaged within the Block-cycle, and only approved by a 'Block' Configuration Control Board which scrutinizes change proposals for their net impacts to the 'end to end' architecture.

'End to End' Testing Prior to Delivery carries forward the holistic approach to Block development to assure the IT-21 Block functions as a single integrated system. This level of testing combines the entire IT-21 Block design as a netted architecture, within SPAWAR labs, to verify its 'end to end' performance characteristics… *before* the total Block package is certified for delivery to Fleet units.

Coordinated OPTEVFOR Block Testing reflects a SPAWAR commitment to involve the Navy's independent Operational Test and Evaluation agency, OPTEVFOR, in the development and suitability testing of the entire IT-21 Block architecture, *as an 'end to end' entity*, early in the Block development cycle. Consistent with OPTEVFOR's

Command goal to make testing a constructive part of system development[8], this collaborative relationship is structured to *build in* suitability by optimizing test events to inform Block development. Despite the fact that many components to the Block architecture have existing OPTEVFOR certifications, and those that don't could be carried forward for test as individual systems, this collective approach to certifying the Block architecture is emblematic of SPAWAR's commitment to a single, fully integrated, C4ISR design.

Pre-packaged Security; Common Certifications undertakes a similar approach to that applied by the OPTEVFOR 'end to end' testing regime, in this case concerned with security accreditations. Thus adherence to Multi-level Security mandates is certified by observation of application security performance within the total network, from individual workstations to off-ship portals. Here the upfront system engineering which pre-planned integration is also at work, anticipating potential vulnerabilities and pre-packing security solutions, such as firewalls or accredited access schemes.

Built-in, Single Delivery ILS adheres - as a support service - to the commonality edicts which define the IT-21 Block design as a whole. Integrated Logistics Support benefits from the commonalities in hardware and software that describe the physical IT-21 plant, and the centralization of management witnessed in the installation process. Training is thus consolidated throughout the SPAWAR claimancy such that schoolhouse instruction can focus first on commonalities in operator procedures and maintenance practices, before attending to differences. Likewise parts sparing and documentation management gain in efficiency, and surety, as centralized management of ILS provides increasingly uniform delivery of services. New ILS capabilities are planned to provide remote training and trouble-shooting, along with centralized documentation and technical support services.

VI. IT-21 BLOCK 1

IT-21 Block 1 represents the evolution of SPAWAR's 'end to end' C4ISR architecture - building *Horizontal Integration* into the network centric services first fielded in its predecessor designs, MIN-IP and IT-21 Plus. In addition, IT-21 Block 1 provides a significant number (90 plus) of C4ISR system improvements.

Block 1 is planned for Initial Operating Capability (IOC) fielding aboard a Fleet Command Ship, currently projected to be USS Coronado (AGF 11), in 2003. Corollary Block 1 designs exist for IOC implementation aboard a Carrier Battle Group, including a CVN, CG, DDG, and SSN. The IT-21 Block 1 design for each hull completed Critical Design Review in May of 2001, and is under configuration management… *requiring approval of SPAWAR's Configuration Control Board for Engineering Change Proposals recommended for any component within the Block design*.

[8] "Operational Test and Evaluation Brief to Defense Science Board Task Force on Test and Evaluation", Hon. Phillip E. Coyle, Director Operational Test and Evaluation; 26 May 1998.

Prototype equipment sets are in place, and currently undergoing developmental testing, in SPAWAR laboratories at San Diego CA, Chesapeake VA, and Charleston SC.

A somewhat rhetorical question is occasionally posed: "What constitutes an IT-21 system?" The question derives from the observation that SPAWAR seeks to field a 'single, end to end' architecture, but surely must field systems incrementally, observing equipment lifecycles and fiscal constraints. The chief response is that an IT-21 Block architecture is more than what gets installed in a given ship or Battle Group during a Block upgrade event. The Block, remember, is a collection of capabilities that results from the Horizontal Integration process. So while some capabilities are gained from new hardware or software, others flow from legacy systems used in ways that pre-plan integration, foster commonality, or are optimized by the effects of coordinated configuration management, ILS, and testing.

The sections that follow, describe the IT-21 Block 1 architecture, not by referring even to most of the systems in the capabilities chain, but by highlighting those features of the new design which best exemplify Horizontal Integration, as it is implemented in the IT-21 Block 1 architecture.

The IT-21 Block 1 design is organized around functional enclaves, which unify design by co-hosting similar services in common infrastructure. Thus communications services are developed in a 'Transport' Enclave, shipboard LAN services are organized within a 'Networks' Enclave, and so on - for all five enclaves, including:

- GENSER
- SCI
- UNCLAS
- Networks
- Transport

Applications Enclaves

Each of the "Application" Enclaves, (GENSER, SCI, and UNCLAS) host software applications for data processing in support of shipboard C4ISR operations. From the outset, it was affirmed for the Block 1 Applications Enclaves that Horizontal Integration and 'commonality' were inseparable. Their systems would be converged – consolidated - to the full extent technology allowed. Server consolidation became the central feature of each of the Application Enclave designs, and the benefits of these consolidations provided key evidence for the wisdom of the HI approach.

Server consolidation:

- Provides economies in ILS and training
- Substantially eases system administration, reducing manning requirements
- Fosters data integration between applications
- Provides network access to database storage devices with immense capacity
- Increases processing capabilities while reducing shipboard 'footprints'
- Saves software licensing costs

- Simplifies security administration
- Extends access to information throughout the served network
- Allows for smooth ‘fail-over’ and quicker restoration by ‘auto-recovery’ routines
- Encourages adoption of unified database management tools, simplifying subsequent application development
- Provides enabling technology for Ultra-Thin Clients and Multi-Level Security via Public Key Infrastructure

The GENSER Enclave, which principally hosts the Navy implementation of the Global Command and Control System – Maritime (GCCS-M) employs two large enterprise servers for the scores of tactical applications that comprise shipboard GCCS-M ‘load outs’. The return to a UNIX based operating system signals intent to join Joint Service GCCS and GCSS counterparts on UNIX common infrastructure to facilitate interoperability, and lend economy to DISA DII COE software development and maintenance. The GENSER Enclave further consolidates NAVSSI (navigation) display and NITES 2000 (meteorology) services on the Unix Enterprise servers, which provide outputs to the ship’s GENSER LAN. LAN multiplexing (LAN MUX) is employed to speed access to communications (OTCIXS, TADIXS, Fleet Broadcast) formerly provided serially. Storage Area Network (SAN’s) devices provide Random Access Independent Disc (RAID) storage capacity in the Terabyte range. A JAVA interface permits access to NT workstations certified on the GENSER network. Functionality enhancements are provided to GCCS-M Integrated Intelligence and Imagery (I3) via the DII COE kernel 4.X.

The SCI (Special Compartment Information) Enclave is very similarly configured with the GENSER Enclave, employing virtually identical hardware to host SCI-GCCS-M, and interface with the SCI LAN. Though consolidation of SCI services is not presently as extensive as the GENSER server design, future plans include migration of the entire family of SCI cryptologic applications (BGPHES, CDF, COBLU, SSEE Increments B & D) to the SCI server host.

The UNCLAS Enclave chiefly provides automated administrative services for shipboard supply, afloat maintenance, and manpower administration; combined within the Naval Tactical Command Support System (NTCSS). The UNCLAS Enclave employs identical SAN devices as its counterpart enclaves, but consolidates applications on high performance COMPAQ/WINTEL servers, owing to the preponderance of existing applications developed for NT. Combined with the NTCSS applications in the WINTEL servers are two additional UNCLAS networked systems: an afloat telemedicine and automated medical reference system, (TMIP-M), and a ship design technical library retrieval system, (ATIS). The UNCLAS Enclave additionally employs intranet web browsing technology, permitting sailors to gain access to full UNCLAS Enclave functionality, from ‘thin client’ workstations, limited only by pre-set authorizations.

Networks Enclave

The Networks Enclave provides 'network centric' infrastructure with high capacity data access, within enclaves, and between enclaves and off-ship communications infrastructure. The Networks Enclave technical approach is interesting, partly because it signals a departure from predecessor MIN-IP and IT-21 Plus designs, which specified Asynchronous Transfer Mode (ATM), as the baseline LAN. This departure is not, however, outside the precepts of the 'The Seven Habits of a Highly Effective Information System', which charged: "We must stay common with industry". Observing that industry solutions were increasingly predominated by Gigabit Ethernet switched networks, and shipboard ATM LANs were proving onerous and expensive to maintain, SPAWAR adopted GIG E in several shipboard implementations even before IT-21 Block 1. The IT-21 Block 1 GIG E Network thus provides 1000mbs service between the Enclave servers and their respective LAN switches, and 100mbs to the desktop.

Transport Enclave

The Transport Enclave provides off-ship communications paths for voice, video, and data, and entry to the ship's baseband communications and network infrastructure. Certainly much essential capability is provided here, particularly witnessing the impressive growth of wideband satellite access, stemming from the expanding bandwidth capabilities of EHF-MDR and INMARSAT B; and the extension of EHF, SHF, GBS, and CWSP, to a widening array of Fleet platforms.

A key technology to future IT-21 implementations, Digital Modular Radio (DMR), is minimally implemented in Block 1, because it is nearing IOC nearly concurrently with Block 1 development. It is, however, an instructive technology, representative of design intentions to seek flexible, common hardware solutions. DMR is a software programmable radio, planned to replace end of life, single purpose radios that are constrained by their hardware linkage to individual waveforms. DMR, when fully implemented, will migrate to Joint Tactical Radio System compliance, and incorporate a wide range of waveforms (UHF, VHF, HF, SINGCARS, etc.) and supplant much of the existing, less flexible, shipboard radio suite.

Two key Transport Enclave contributions to the IT-21 Block 1 effort, are not official components of the Block 1 design, but experiments constructed to prove technologies for future Block incorporation. The first involves implementation of advanced routing technologies to demonstrate improvements in 'Quality of Service' and 'Dynamic Bandwidth Management' through the ship's Automated Digital Network System - the Transport interface to the IT-21 GIG E LAN. The second experiment tests capacity of 'Intra-Battle Group Wireless Networking' to defer voice, video, and data loading away from SATCOMM channels to line of sight of communications paths within the Battle Group.

VII. IT-21 BLOCK 2

Evolving Requirements, Emerging Technology

IT-21 Block 2 is both a logical successor to Block 1 and a significant departure point. It is necessarily derived from its Block 1 ~ Horizontal Integration ~ heritage, but differs and expands upon Block 1 in key regards. Block 2:

- Represents a first of its kind endeavor to align, assess, and develop the 'end to end' C4ISR architecture based on Fleet Mission Requirements.
- Signals a renewed opportunity to evaluate and insert compelling technologies across enclaves which improve speed of command, reduce Total Ownership Cost (TOC), and improve reliability (Ao).
- Seeks synergistic integration with emerging priority Navy IT and Command and Control programs, such as Task Force Web and Naval Fires Network.

Even as IT-21 Block 1 was in the early stages of design, a separate and distinct directive was charged to the Block 2 Planning Team: *Begin the design with Fleet requirements*.

To be sure, the Block 1 design is defined by its commission to improve 'end to end' capabilities. Experience in fielding initial C4ISR packages clearly vouched for the wisdom of commonality, pre-planned integration, and improved maintainability. These capability improvements are, however, derived almost entirely from the *engineering* process improvements described as Horizontal Integration. Notwithstanding the advantages Block 1 designs provide to every C4ISR mission area, it remains that Block 1 is predominated by its ability to align and integrate *systems*. Significantly, even as IT-21 Block 1 is in the laboratory proving its design virtue, SPAWAR leadership has maintained an abiding desire to reset the units of measure.

"Requirements Pull"

The performance characteristics of Block 1 are currently codified as "Key Performance Parameters" (KPP's) and form the basis for OPTEVFOR evaluation. To the extent that these KPP's largely aggregate the performance features of Block 1's legacy subsystems, they tend to report advancements in system capabilities…or "technology push".

Block 2 signals the deliberate evolution of SPAWAR's IT-21 strategy by commencing design activities with thoroughgoing analyses of Fleet mission requirements. These analyses are intended to inform the Block 2 architecture by establishing the need for quantifiable end state capabilities…or "requirements pull".

Block 2, already having advantages in lead-time and Block 1 design experience, has been fortunately met and guided by a Navy-wide initiative, directed by OPNAV N6, to define mission requirements and align ship designs to satisfy them. This initiative, described by its "Mission Capability Packages" (MCP's), is first *(and last)* a strategy to order resource allocations in consultation with Fleet Operating Forces, such as Commander Fleet Forces Command, to optimize capabilities for prioritized mission sets.

The MCP's are organized by two sets of mission categories, Operational – referring to traditional warfare areas, and Domain – which describe functional capabilities which span the range of warfare areas.

Operational MCP's

- TST – Time Sensitive Targeting
- TAMD – Theater Air Missile Defense
- USW – Undersea Warfare
- EXW – Expeditionary Warfare
- HLS – Homeland Security
- SD – Strategic Deterrence

Domain MCP's

- BFC2 – Battle Force Command Control
- ISR – Intelligence, Surveillance, and Reconnaissance
- NAV – Navigation.

OPNAV has assigned each of the Mission Capability Packages to a Mission Area Coordinator (MAC). The MAC is charged with conducting requirements analyses to specify the capability attributes necessary for success in the mission area. Thereafter, the MAC will conduct assessments of existing and proposed architectures to evaluate their suitability with regard to identified requirements. These architecture assessments are intended to shape total ship designs by fostering promising technologies, and optimize resource allocations for maximum impact in the Mission Area.

In several cases, ISR for example, SPAWAR is the 'Lead Laboratory' and the MAC is an OPNAV assigned action officer from within the SPAWAR Claimancy. For *every* MCP, SPAWAR has internally assigned an action officer, a SPAWAR MAC, to conduct C4ISR needs assessments, and propose architecture and resource alignments which best serve Mission Area capabilities. These MCP assessments are planned to form the basis for the "requirements pull" which is intended to inform development of the IT-21 Block 2 architecture.

Technology Insertions

Though Block 2 is to be characterized by its alignment to mission requirements, it is also necessarily tied to the emergence of key technologies spiraling from the IT Revolution. These technological opportunities urge consideration for early adoption, and re-invigorate the dialogue between capabilities and requirements. However it troubles orderliness, even strident advocates of top-down, requirements based design must concede that the value of many technologies became evident before requirements for their services were formally specified. Examples proliferate, including video teleconferencing, shipboard wireless networks, un-attended sensors, and nose-cone targeting video.

A short list of Block 2 candidate technologies might include:

- Radio Room Automation
- Voice, Video, Data over IP
- Embedded Training
- Multi-Level Security
- Ultra-Thin Clients
- Advanced Collaboration Tools
- Visualization Tools, Knowledge Based Displays
- Storage Area Networks
- Clustering
- Wireless Networking
- Advanced C4ISR and Combat System Integration

IT-21 Block 2 is inherently driven by evolving technologies, and its designers are duty bound to survey and assess the value of any technology which improves net C4ISR performance or reduces total ownership cost.

Integration With Priority Navy IT and Command and Control Programs

SPAWAR's obligation to field highly competent, reliable, and cost effective C4ISR systems ends anywhere but at the lifelines. SPAWAR is a key partner in implementing several vital Navy C2 and IT initiatives, which the SYSCOM does not directly manage. These burgeoning Network Centric Warfare programs - including *Force Net, Task Force Web, Naval Integrated Information Network, and Naval Fires Network* - insist that Block 2 plans incorporate and complement the new capabilities, and seek to extend IT-21 design principles throughout the Fleet's C2 and IT architecture.

Defining Block 2

Change and re-invention have been hard earned for IT-21 Block 1, and the complete design and budget process remains somewhat dynamic. The forces which compete to propel and impede change are no less pronounced or complex when it comes to defining the objective architecture for IT-21 Block 2. MCP assessments are in their first iteration, and their impacts on future procurement budgets are a matter of prediction. Budget realities constrain research and development, and not infrequently favor legacy engineering approaches. Affirming the urgency and merit of Navy/Joint C2 and IT initiatives still requires attentive planning by IT-21 design teams, and further allocations of human and fiscal resources.

Within this context, IT-21 Block 2 is presently understood best by its influences: SPAWAR's commitment to apply proven Horizontal Integration process improvements to realize Network Centric capabilities; OPNAV and SPAWAR resolve to reason design by output capabilities and cost; and the learned appreciation that legacy systems and new technologies each bear accounting for their impacts on bottom line capabilities and ownership costs. These defining features are a creative dynamic for IT-21 Block 2 - as it

continues to be guided by its Horizontal Integration heritage, and the design principles intrinsic to the IT-21 Strategy.

X. SUMMARY

IT-21 reflects SPAWAR's commitment to optimizing Navy "network centric warfare" capabilities. Building on the success and lessons learned of predecessor implementations, SPAWAR has undertaken a series of process improvements to create capability packages in the IT-21 Block 1 architecture. These process improvements, referred to as '*Horizontal Integration'*, pre-plan integrated system capabilities, invoke rigorous configuration management, 'build in ILS', and conduct 'end to end' testing to prove design efficacy before Fleet delivery. The IT-21 Block 1 architecture is characterized by these process improvements, and several key design features, including: hardware commonality, server and network consolidations, enhanced access via GIG E LANS, and innovative strategies to maximize available transport bandwidth. The IT-21 Block 2 architecture is poised to capitalize on anticipated technology advances, and moreover, focus system development and procurement resources on future mission needs. The IT-21 design and fielding process continues to be informative in identifying strategies to optimize capabilities by efficiently delivering cutting edge technologies to current and future warships.

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List of Acronyms

ARG	Amphibious Ready Group
ATIS	Advanced Technical Information System
BFC2	Battle Force Command and Control
BG	Battle Group
BGPHES	Battle Group Passive Horizon Extension System
C4ISR	Command, Control, Computers, Intelligence, Surveillance, and Reconnaissance
CDF	Combat Direction Finding
COBLU	Cooperative Outboard Logistics Update
COTS	Commercial Off the Shelf
CVBG	Carrier Battle Group
CWSP	Commercial Wideband Satellite Program
DII COE	Defense Information Infrastructure Common Operating Environment
EHF-MDR	Extreme High Frequency – Medium Data Rate
GBS	Global Broadcast System
GCCS-M	Global Command and Control System – Maritime
GCSS	Global Command Support System (DISA)
GENSER	General Services (SECRET & below communications, intelligence data)
GIG E	Gigabit Ethernet
ILS	Integrated Logistics Support
INMARSAT	International Maritime Satellite
IOC	Initial Operating Capability
ISR	Intelligence, Surveillance, and Reconnaissance
MIN-IP	Minimum IP (capability)
NAVSSI	Navigation Sensor System Interface
NIPRNET	Non-Classified Internet Protocol Router Network
NITES 2000	Naval Integrated Tactical Environmental Subsystem
NTCSS	Naval Tactical Command Support System
OPTEVFOR	Operational Test and Evaluation Force
OTCIXS	Officer in Tactical Command Information Exchange System
QoS	Quality of Service
SCI	Special Compartmented Information
SCN	Shipbuilding and Conversion, Navy (i.e. new construction)
SINCGARS	Single Channel Ground & Airborne Radio System
SIPRNET	Secret Internet Protocol Router Network
SSEE	Ship's Signal Exploitation Equipment
TADIXS	Tactical Data Information Exchange System
TMIP-M	Theater Medical Improvement Program– Maritime
UNCLAS	Unclassified